

Comparison of NOAA and NASA N20 VIIRS Solar Band SDR Performance over DCCs

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JPSS VIIRS SDR Team Telecon

Background

- NOAA-20 VIIRS RSBs have been very stable, no significant degradation observed to date.
- GSCIS recommends NOAA-20 VIIRS as the visible reference.
- The differences between NOAA STAR and NASA VCST NOAA-20 VIIRS RSB on-orbit calibrations are small, ~0.2% or less for most bands.
- It is still useful to quantify the small trends in the NOAA and NASA N20 VIIRS RSB SDRs:
The mission-long calibration stability requirement for VIIRS RSBs is 0.3%.
0.1% stability is desired for OC applications.
- NOAA-20 VIIRS data records are still short (3 years), it is challenging to quantify the small trends using most of vicarious methods:
 - Limited data points are available so far for lunar cal, desert sites, SNO.

Goal: to quantify the trends (with uncertainty) and biases in NOAA and NASA N20 VIIRS RSB SDRs using the daily DCC method.

The Daily DCC Method for VIIRS

Wang and Cao, 2020, IEEE JSTARS

- The same DCC identification criteria are used as the monthly DCC method (*Doelling et al. 2013*), while mode & mean of DCC reflectance are calculated daily.
 - ~300,00 DCC pixels are available daily ($\pm 25^\circ$ latitude).
 - Anisotropic effects in VNIR bands are corrected using HU2004 ADM. Residual annual cycles are reduced using an annual cycle climatology developed using reprocessed S-NPP data.
- Estimation of 95% confidence interval (CI) of linear trend:

$$\sigma_b = \sqrt{\hat{\sigma}^2 / S_{xx}}$$
$$S_{xx} = \sum_{i=1}^n (x_i - \bar{x})^2$$
$$\hat{\sigma}^2 = \frac{\sum_{i=1}^n (y_i - y_{i,\text{fitted}})^2}{n - 2}$$

$$\text{CI} = b_1 \pm t_{\alpha/2, n-2} \cdot \sigma_b$$

Montgomery and Runger, 2018

b_1 – linear trend

For 95% CI: $t_{0.025, n-2}$ is close to 2.

- DCC mode time series are used for VNIR individual band calibration stability analysis.
- DCC mean time series are used for SWIR individual band stability analysis, and NASA/NOAA bias estimation for all bands.
- Trends derived using the daily DCC time series are similar to those from the monthly time series, with smaller uncertainty due to its higher temporal frequency (~1100 data points for NOAA-20)

Data Used

- 3-year of NOAA and NASA data were analyzed.
 - 1/6/2018 – 1/5/2021
- NOAA NOAA-20 VIIRS SDRs
 - Reprocessed (1/6/2018 – 4/30/2018)
 - Operational (5/1/2018 – 12/31/2020)
 - **Constant F-factors were used for the entire data records.**
- NASA NOAA-20 VIIRS L1B data
 - Collection 2 L1B data downloaded from <https://ladsweb.modaps.eosdis.nasa.gov/archive/allData/5200/>
- The calibration stability and NASA/NOAA biases for M1-M5, M7, and M8-M11 were analyzed.

M1

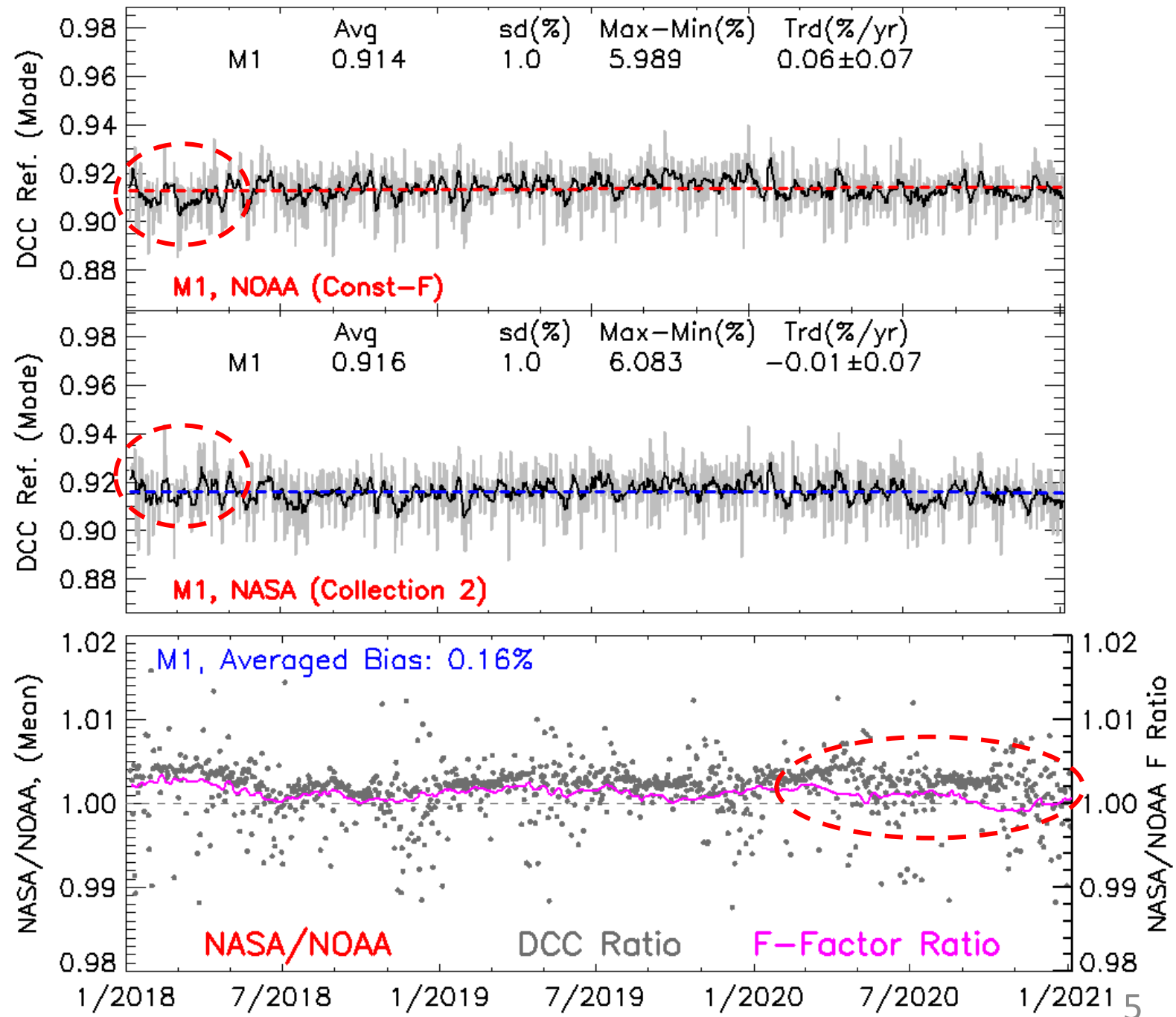
➤ M1 calibration is very stable.

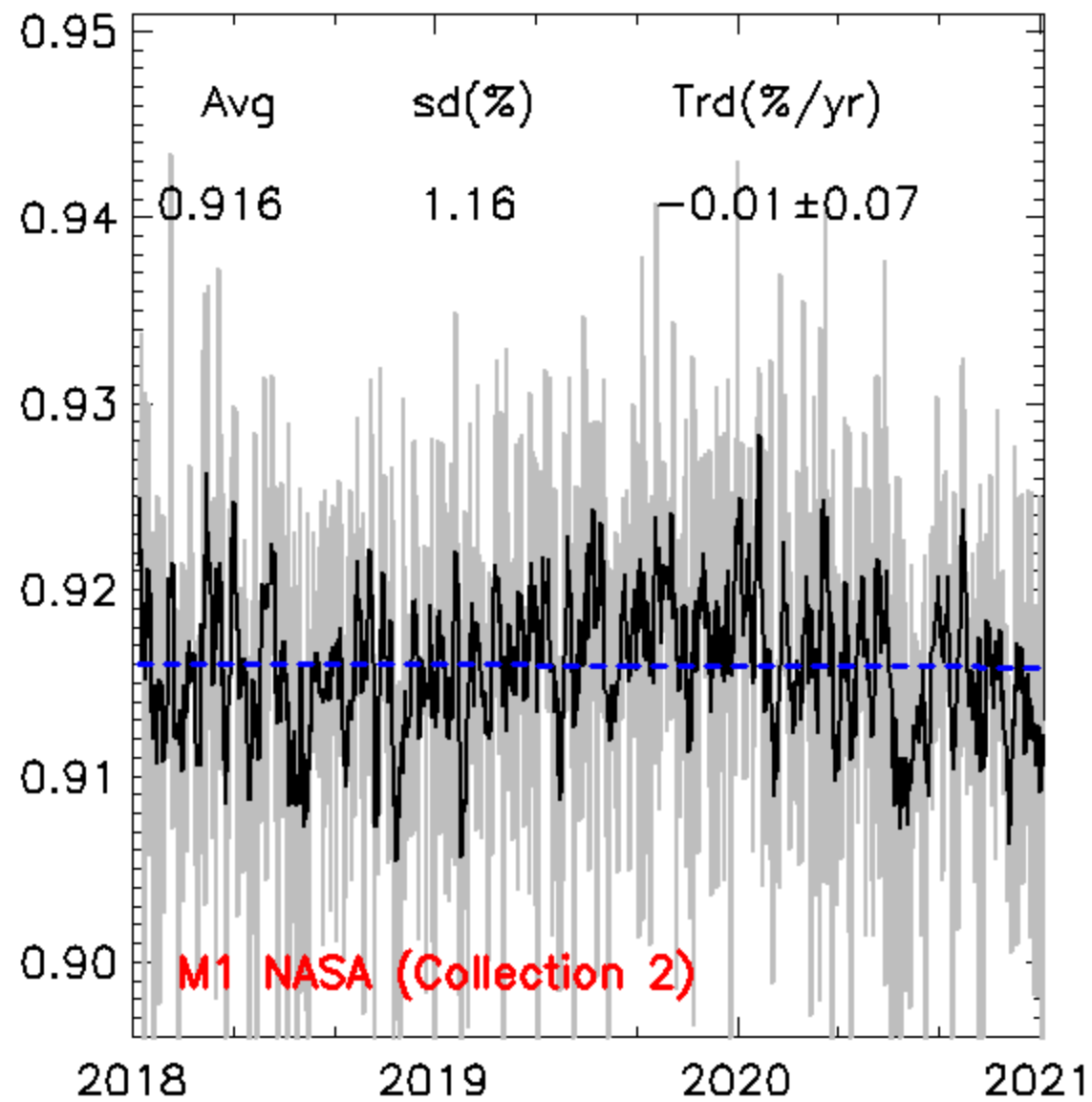
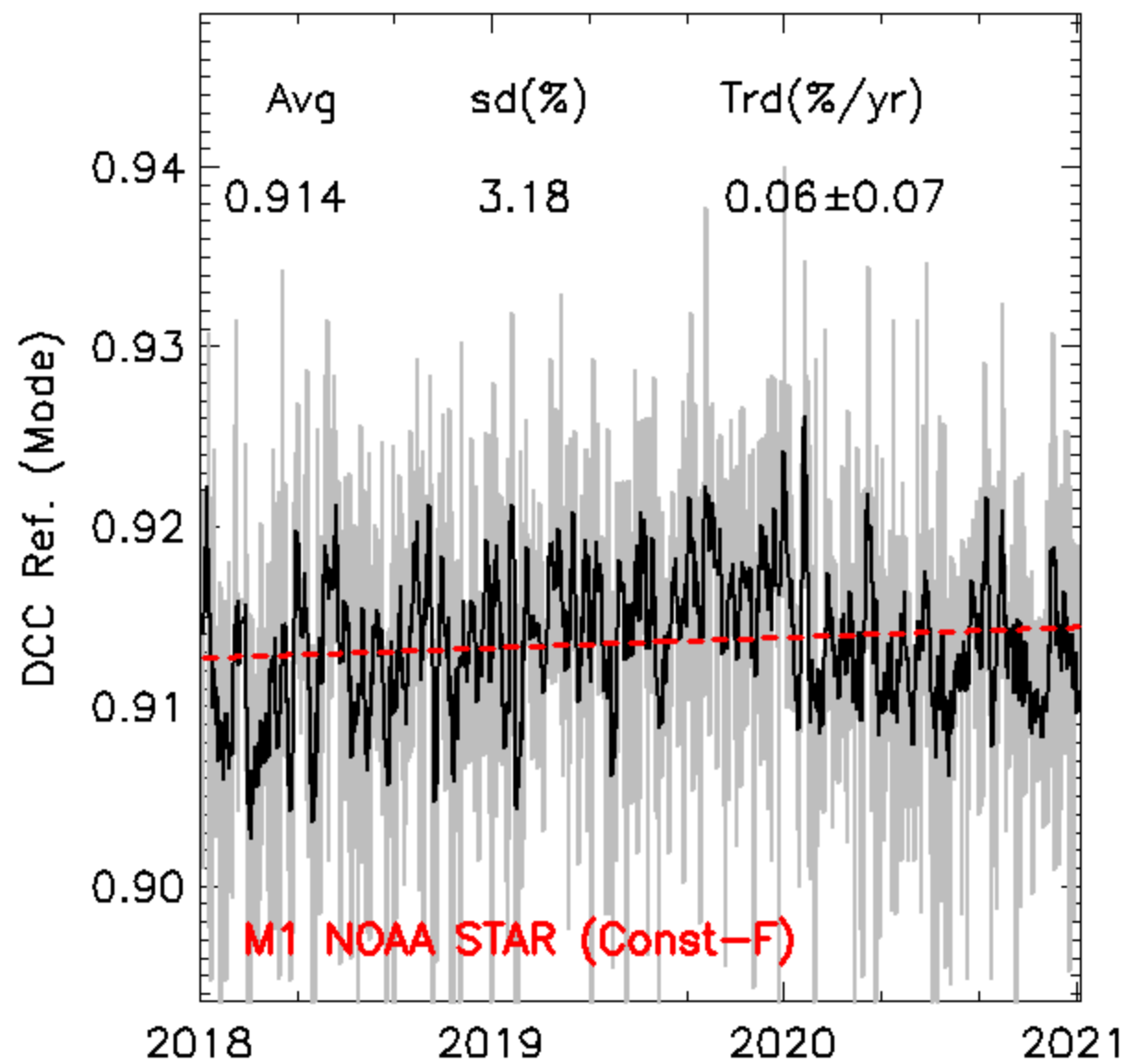
Trends are within the uncertainty level for both NOAA and NASA

NASA M1 shows smaller trend.

➤ NASA/NOAA average bias: 0.16%

- DCC and F ratio time series match better during 2018-2019.
- Larger mismatch during 2020: need to be further investigated. Potential factors: NASA F-factor updates, RVS update, M15 BT, ...?



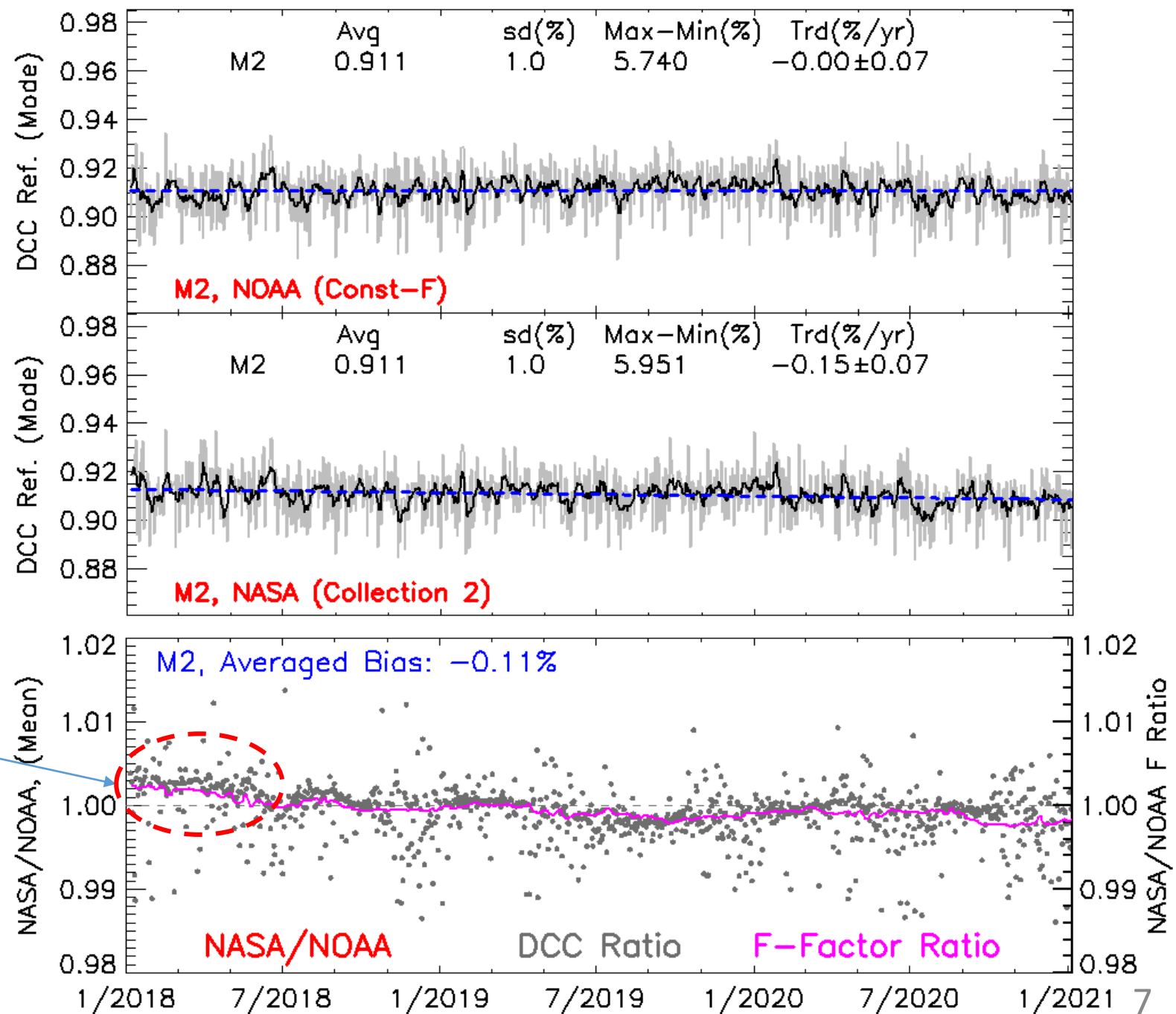


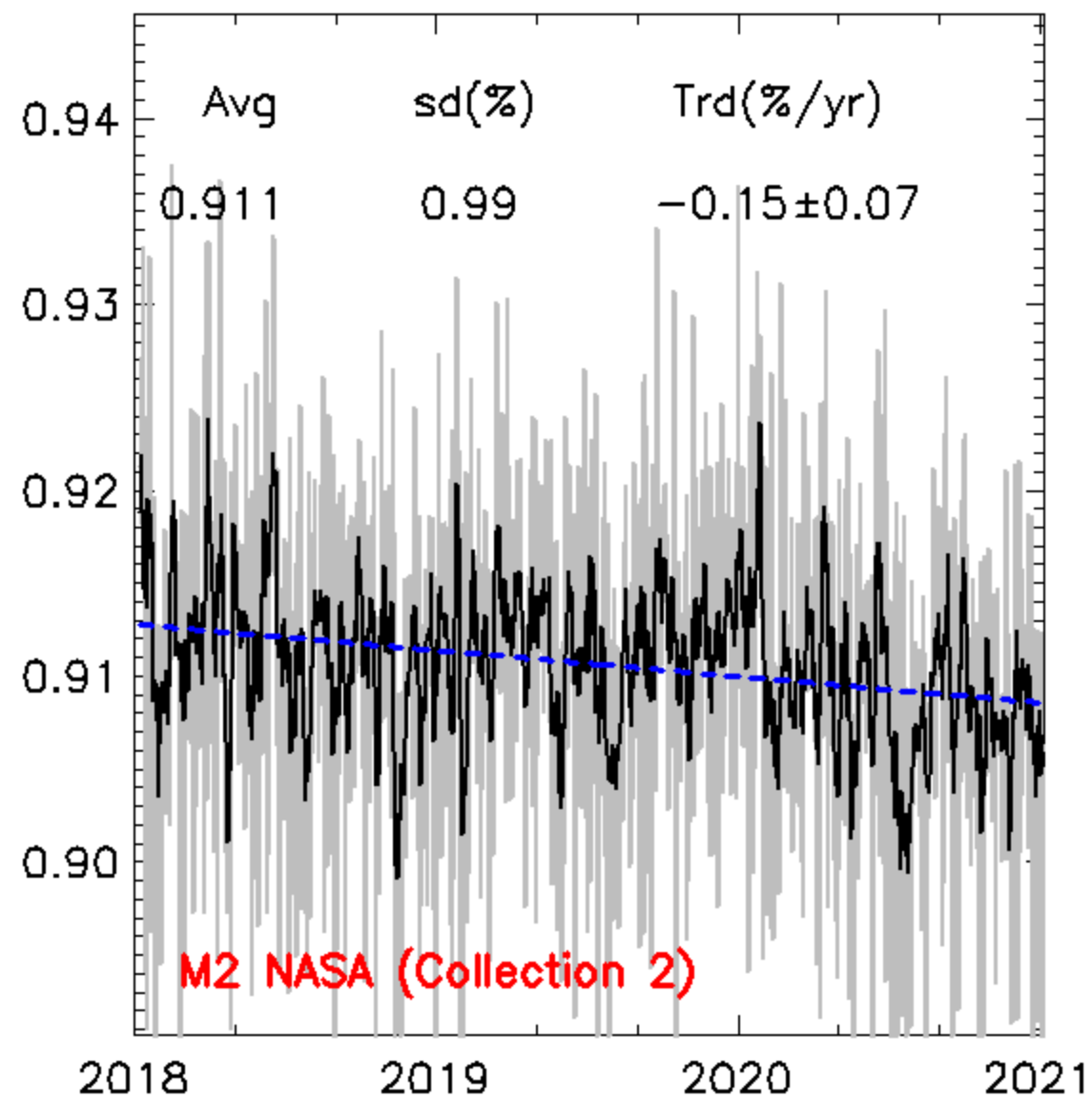
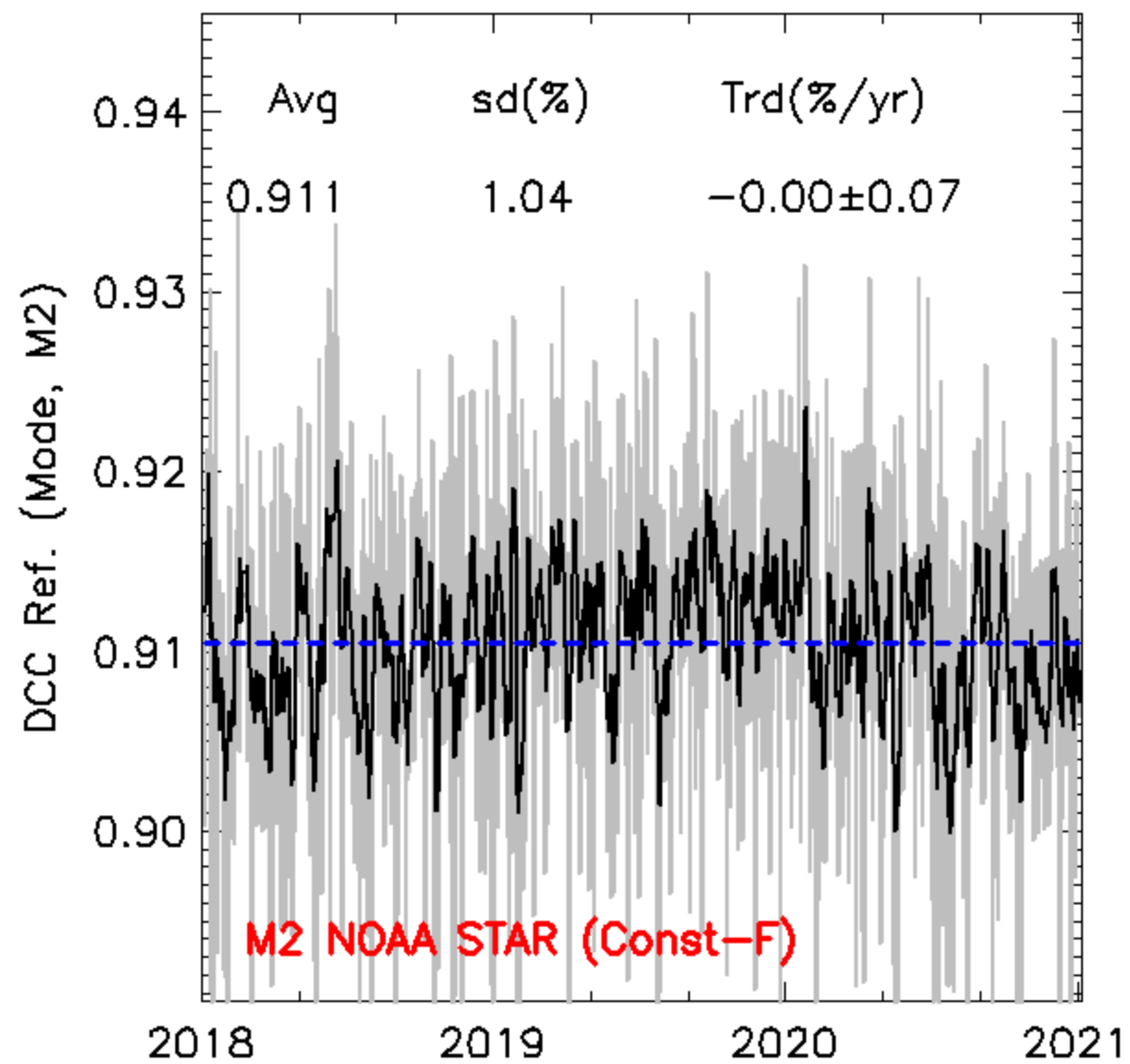
M2

- NOAA M2 shows no trend.
- NASA M2 shows small downward trend
-0.15%/year
- NASA/NOAA average bias:
-0.11%.

DCC and F ratio time series match well.

- Results for M3 & M4 are similar to M2.





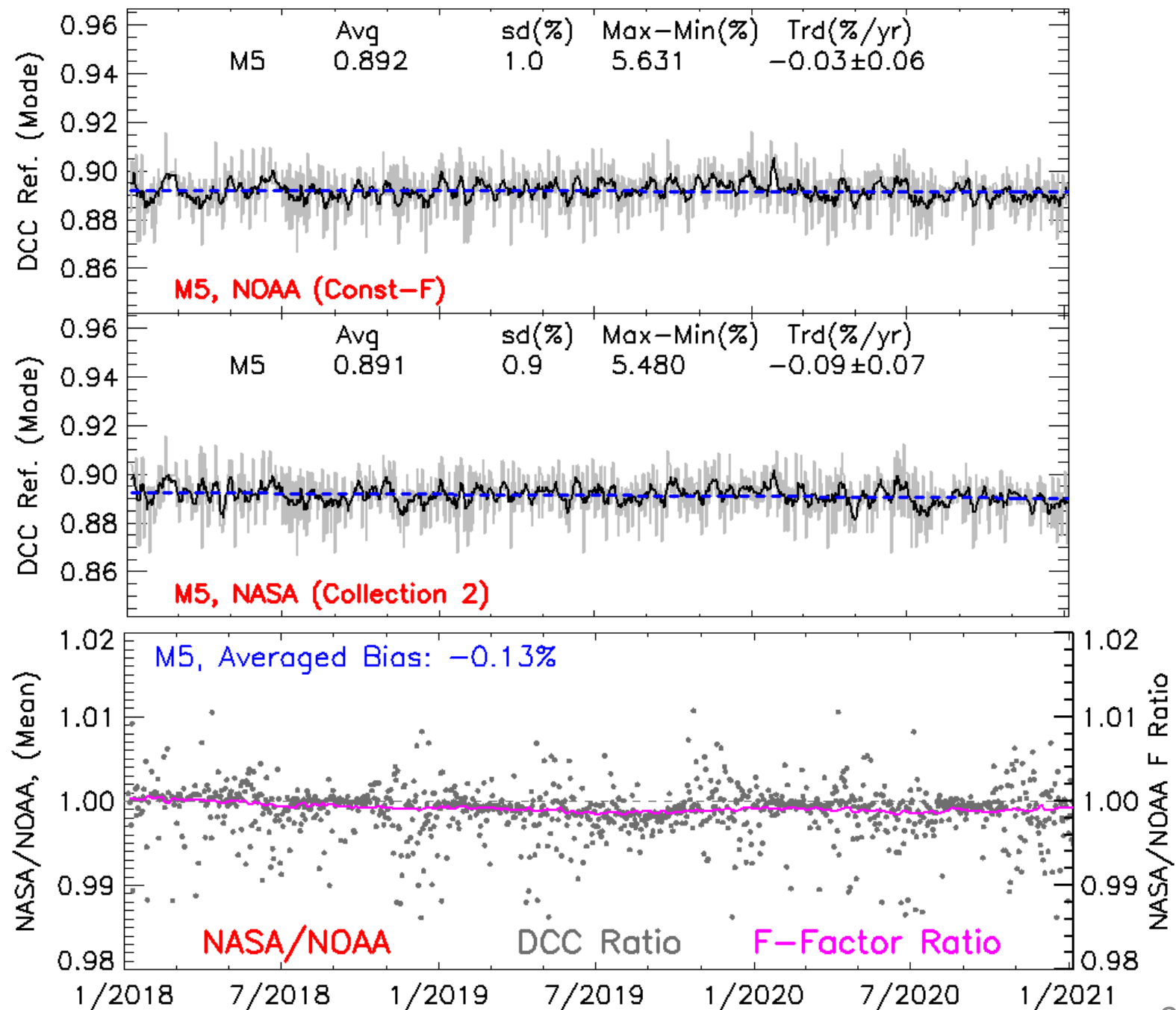
M5

- M5 calibrations are stable.

Trends are within or similar to the uncertainty level.

- NASA/NOAA average bias: -0.13%

DCC and F ratio time series match well.



M7

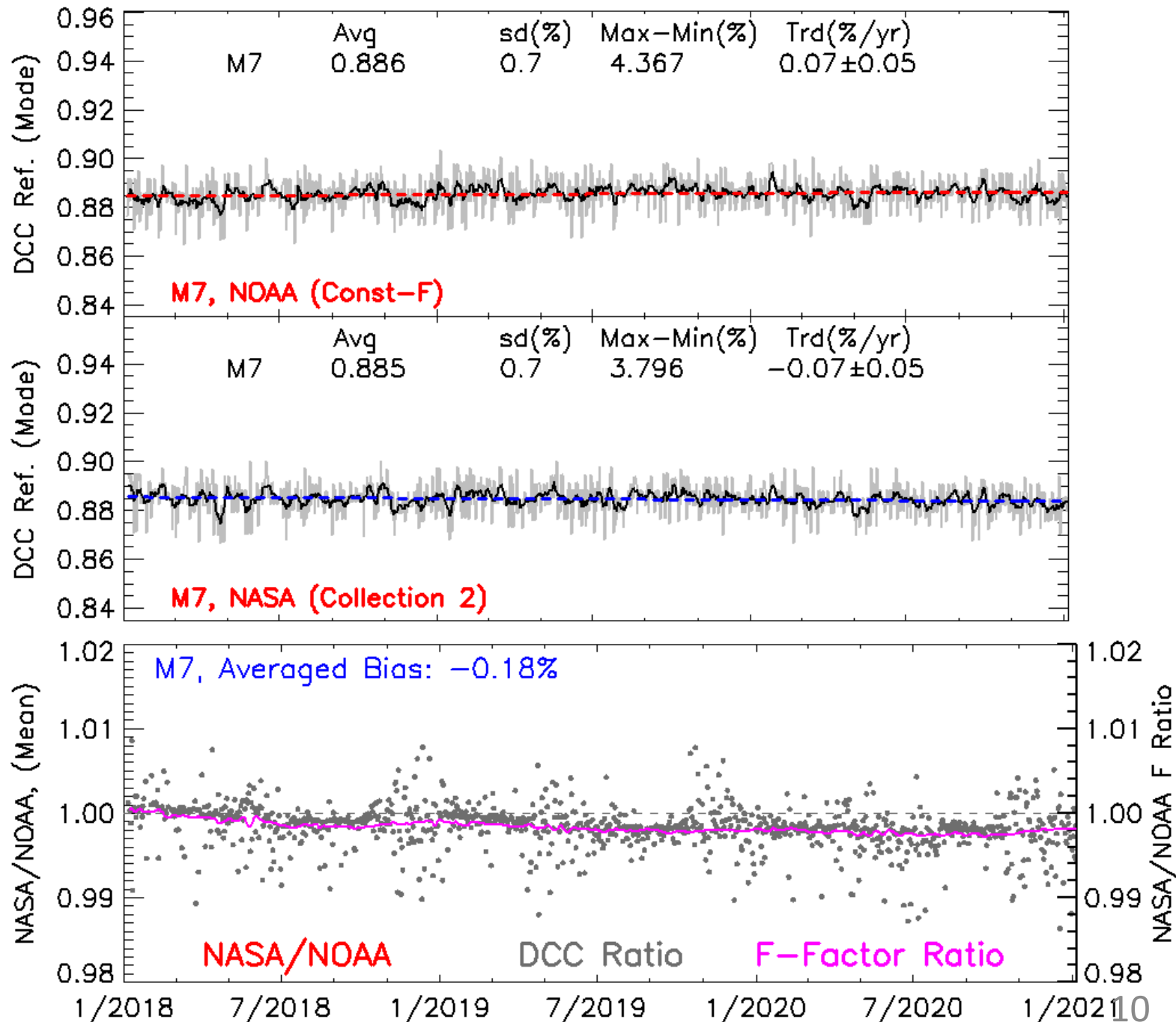
- Small trends in opposite directions:

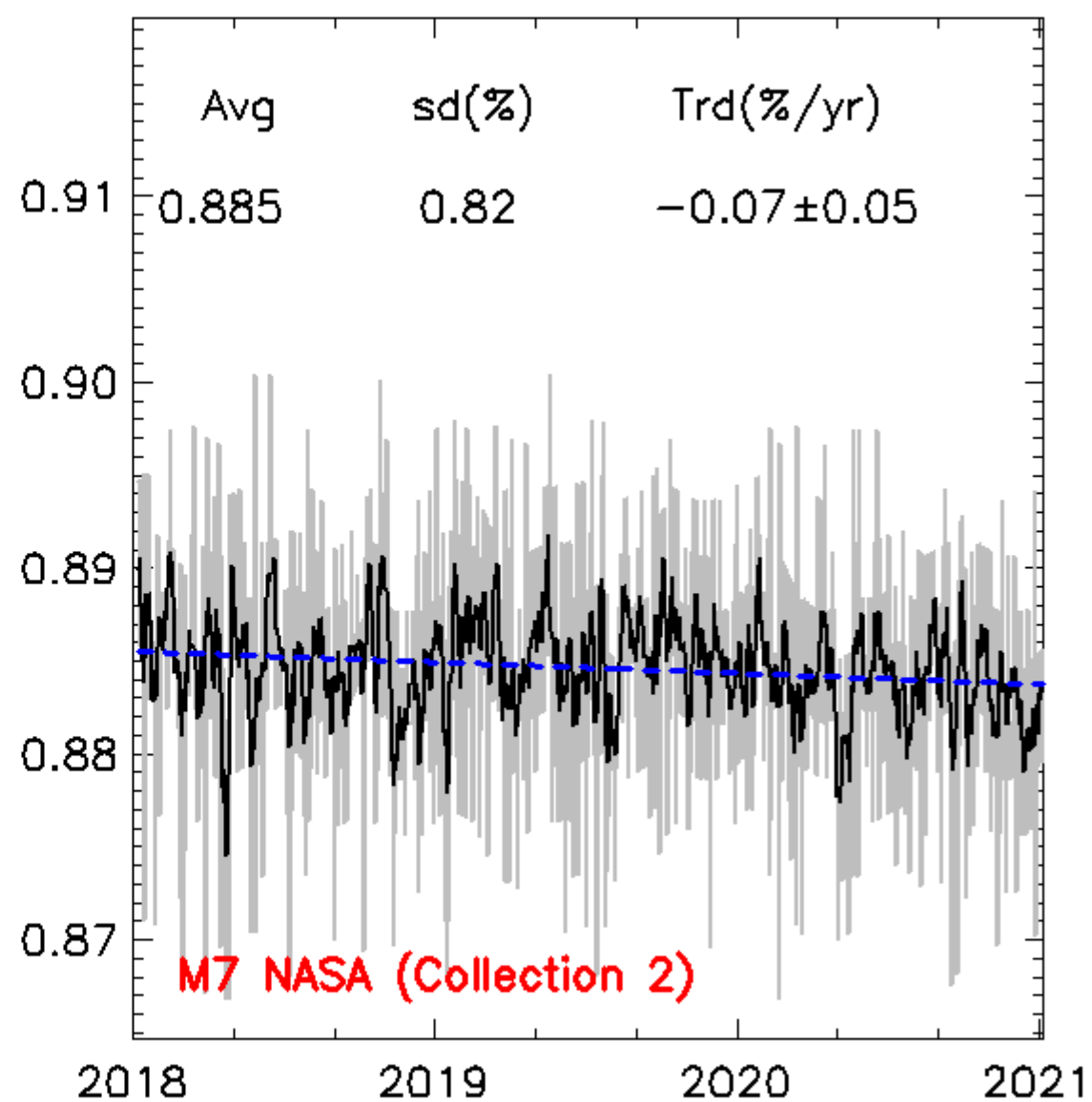
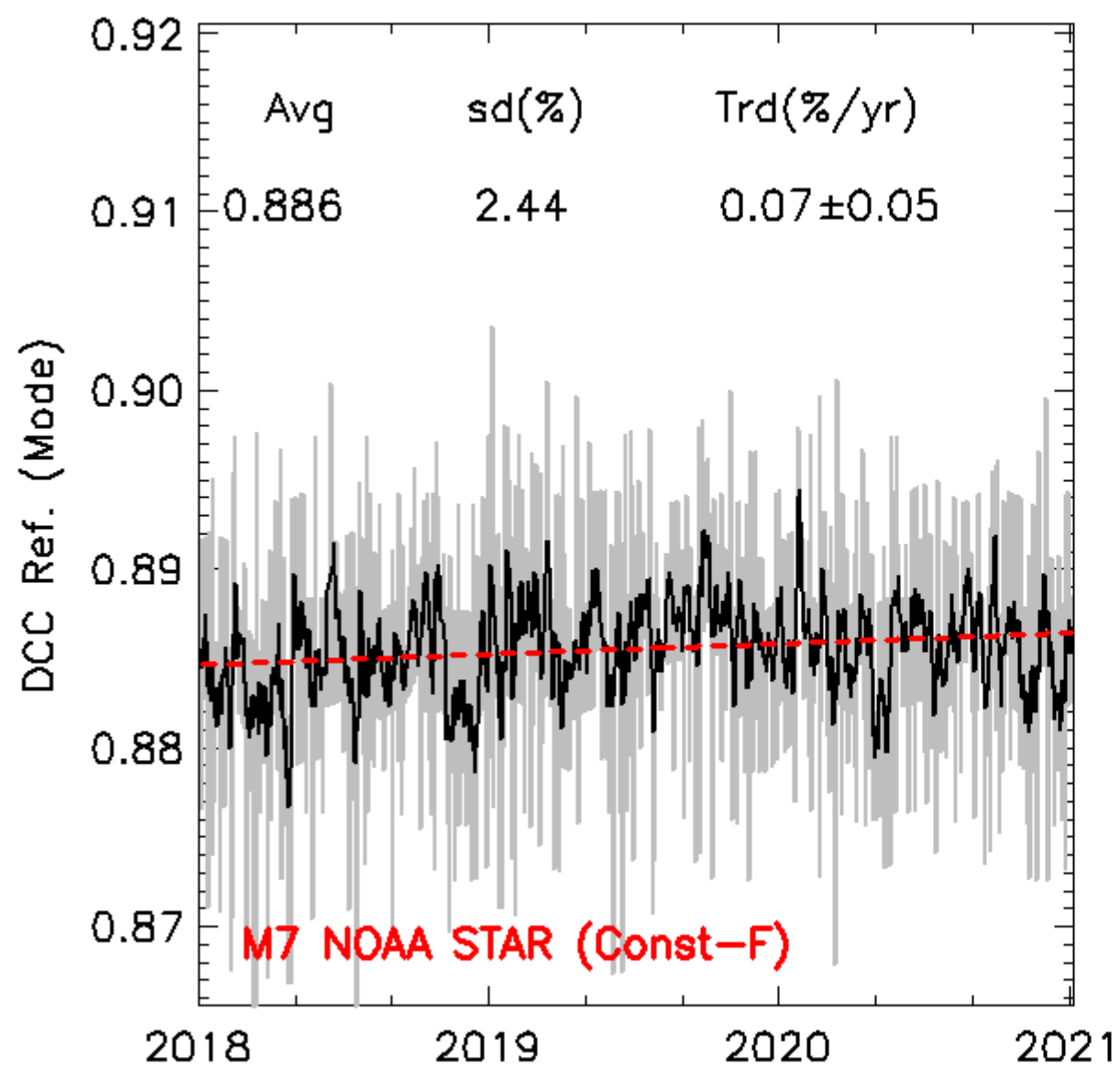
NOAA: +0.07%/year

NASA: -0.07%/year

- NASA/NOAA average bias: -0.18%.

DCC and F ratio time series match well.





M11

- Small upward trends were observed in M11.

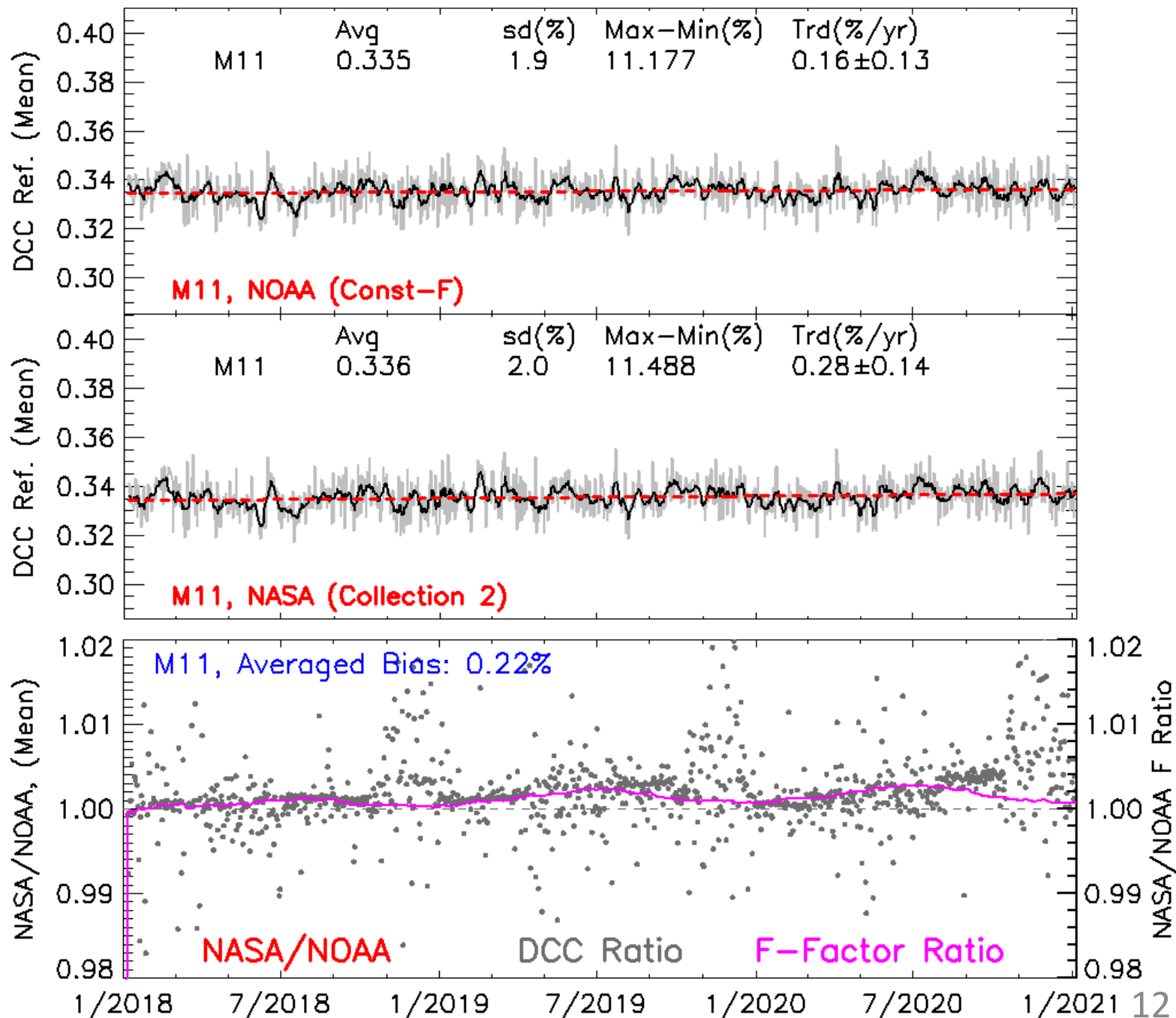
NOAA: 0.16%/year

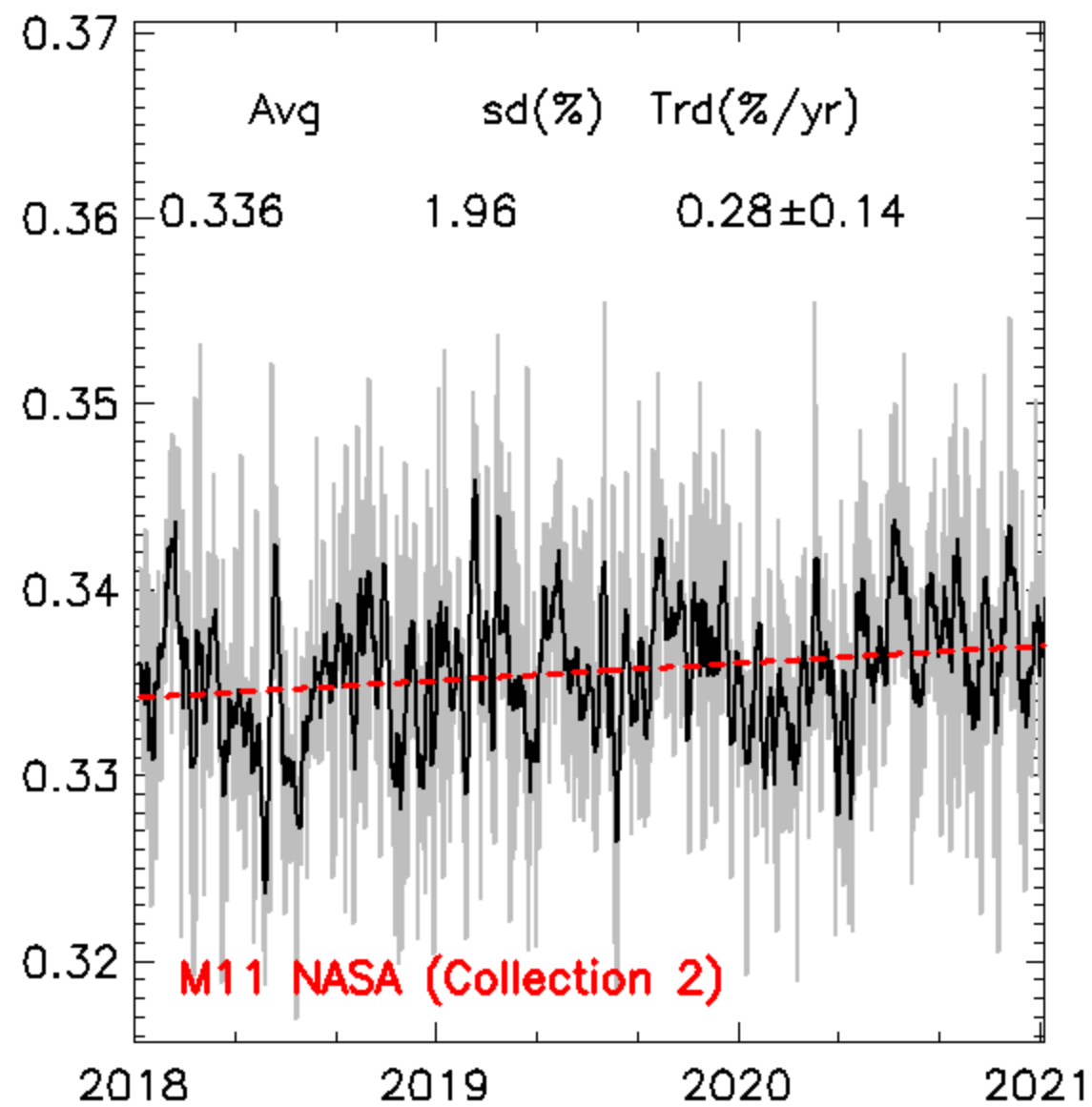
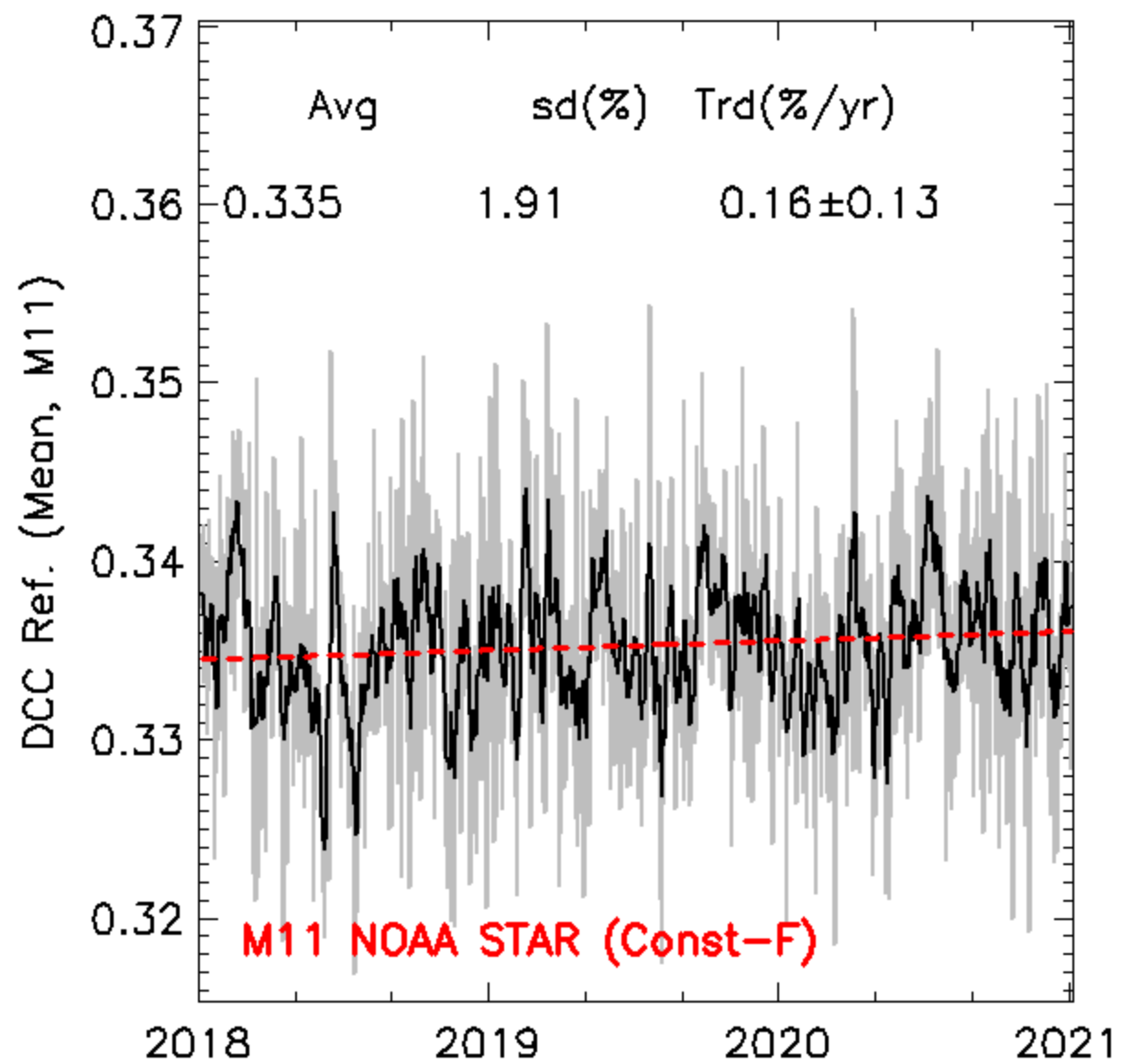
NASA: 0.28%/year

- NASA/NOAA average bias: -0.18%.

DCC and F ratio time series match well.

- Small upward trends were also observed in M8-M10.





NOAA (Constant F) vs NASA (C2) (1/6/2018 – 1/5/2021)

		NOAA(Const-F)	NASA (Collection 2)	NASA/NOAA Avg Bias(%)
VNIR	M1	0.06 ± 0.07	-0.01 ± 0.07	0.16
	M2	-0.00 ± 0.07	-0.15 ± 0.07	-0.11
	M3	0.03 ± 0.07	-0.13 ± 0.07	-0.10
	M4	0.01 ± 0.07	-0.13 ± 0.07	-0.14
	M5	-0.03 ± 0.06	-0.09 ± 0.06	-0.13
	M7	0.07 ± 0.05	-0.07 ± 0.05	0.18
SWIR	M8	0.10 ± 0.07	0.14 ± 0.07	0.01
	M9	0.21 ± 0.16	0.27 ± 0.16	0.03
	M10	0.24 ± 0.17	0.30 ± 0.17	0.03
	M11	0.16 ± 0.13	0.28 ± 0.14	0.22

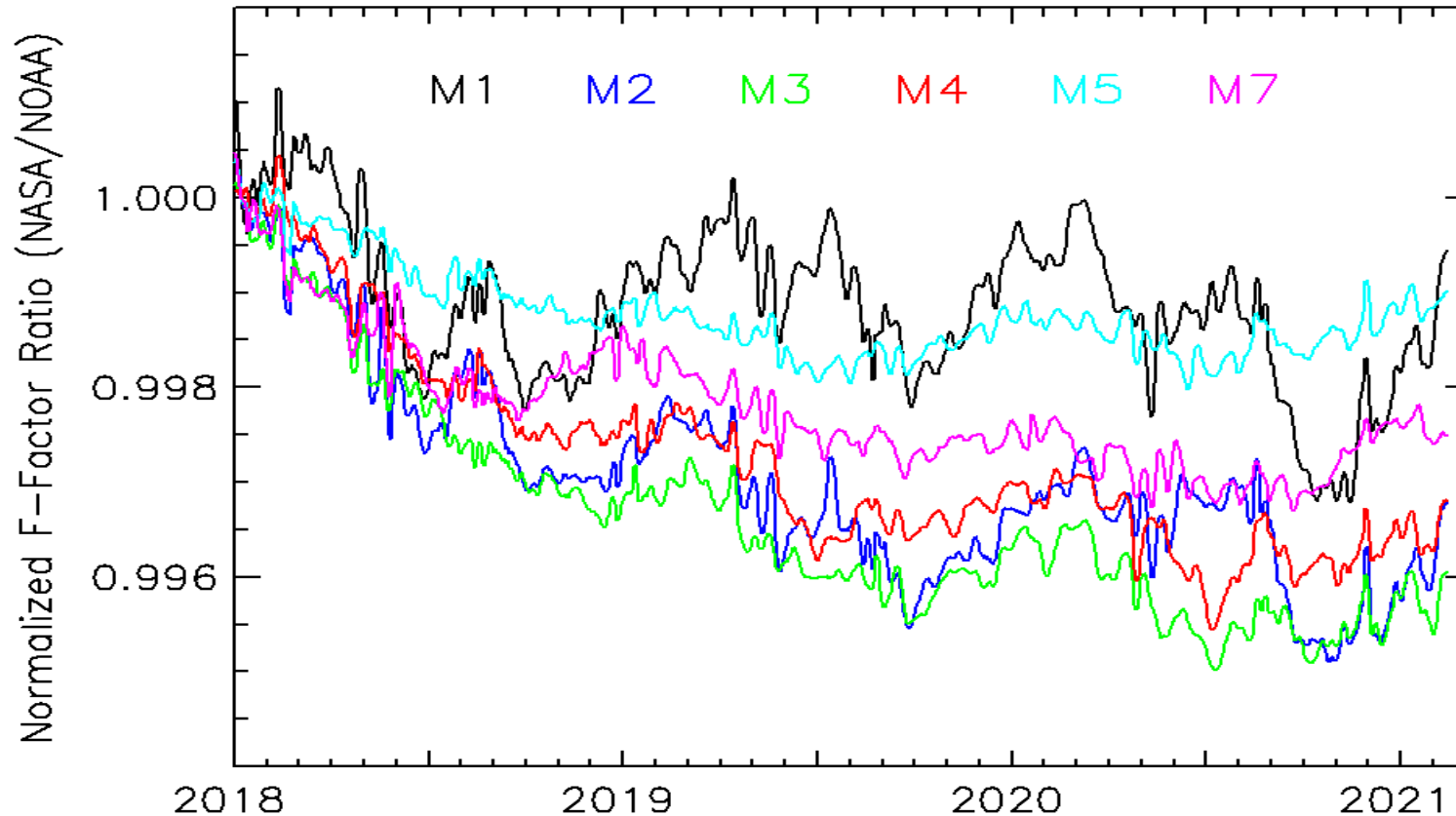
Trend \pm 95%CI Unit: %/year

Summary

- NOAA and NASA N20 VIIRS RSB SDRs were analyzed using the daily DCC method.
 - NOAA SDRs Used: Calibrated using constant F-factors.
 - NASA SDRs Used: Collection 2 L1b products.
- NASA/NOAA average biases are less than $\sim 0.2\%$, consistent with results from other methods.
- NOAA-20 daily DCC time series indicate that there is no significant drift over time:
 - Trends in all VNIR bands (M1-M5, M7) are small:
 - From $-0.03\%/year$ to $+0.07\%/year$ (NOAA)
 - From $-0.01\%/year$ to $-0.15\%/year$ (NASA).
 - Relative larger upward trends were observed in SWIR bands (M8-M11).
 - Up to $0.24\%/year$ (NOAA)
 - Up to $0.30\%/year$ (NASA)
- Next: results from the daily DCC method will be compared to that from other vicarious method, after longer NOAA-20 VIIRS data records become available.

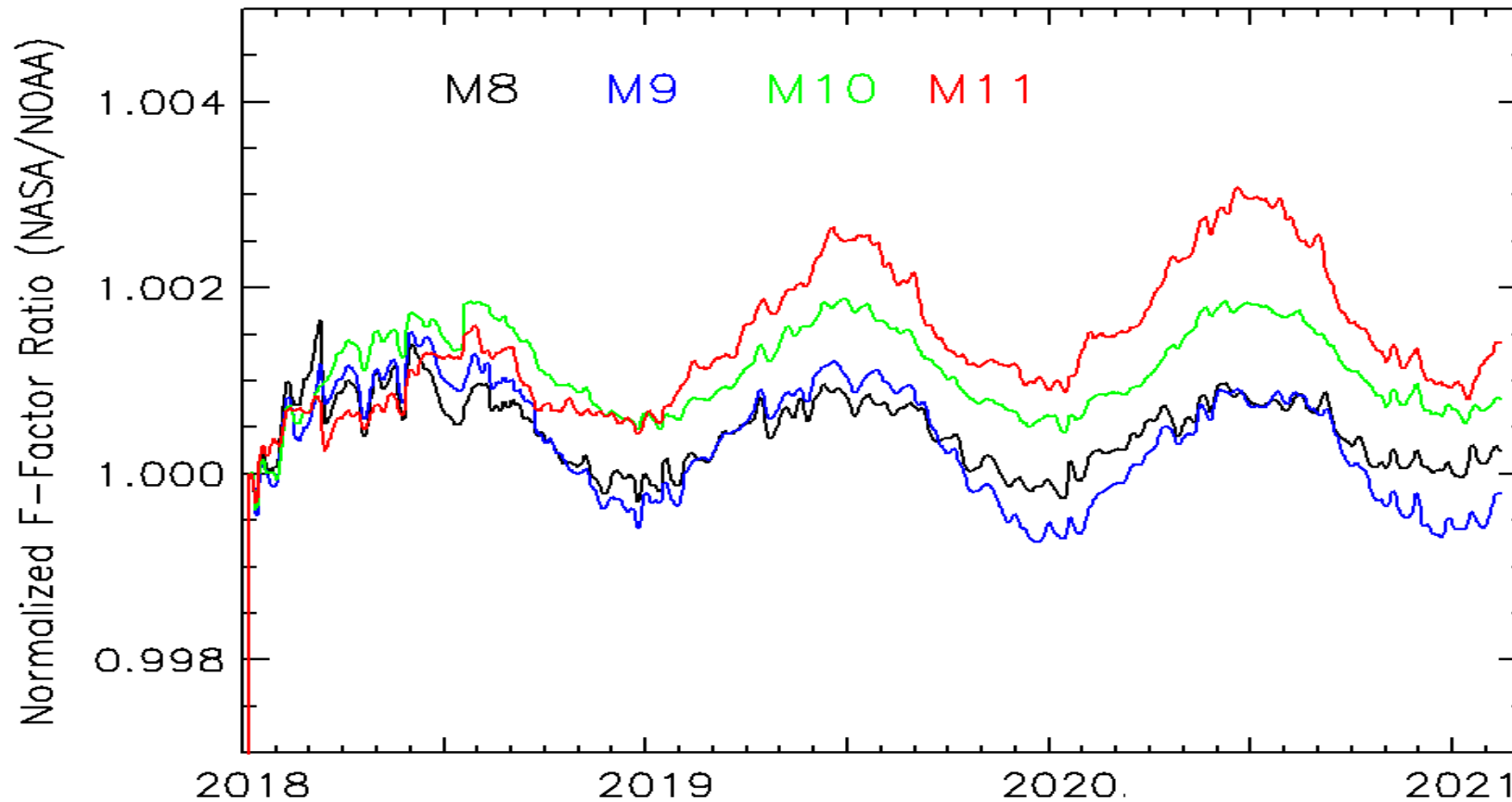
Backups

Normalized F-Factor Ratio (NASA/NOAA, VNIR)



- The differences between NASA and NOAA VNIR F-factors are within 0.5%.
- NASA VNIR F-factors show downward trends in 2018.

Normalized F-Factor Ratio (NASA/NOAA, SWIR)



- The differences between NASA and NOAA SWIR F-factors are small (<0.3%).
- M11 shows relative larger differences during 2019 - 2020.